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The Ring Nebula in Lyra. By Edward S. Holden, LL.D., Foreign Associate of the R.A.S., Director of the Lick Observatory.

In order to give or to obtain an idea of the power of the 36-inch Clark refractor of the Lick Observatory, it is necessary to compare its performance with that of other telescopes on familiar objects. One of the first objects examined here was the ring nebula of *Lyra*; and I wish to communicate a few particulars regarding its aspect in this telescope, not so much for their strictly scientific value, as to enable others (and myself) to estimate the gain of power by the use of the 36-inch lens.

I had the honour of communicating a note on the same subject to the Society in 1875, which was printed in the *Monthly Notices* for December of that year. I have re-read that note, and the various papers there referred to, and compared them with a pastel drawing of the nebula made by me in 1875 with a power of 400 on the 26-inch refractor at Washington. I find the description of the Washington observations fairly exact, and the pastel drawing to be a good representation of the aspect there. This drawing is deposited in the library of the Lick Observatory. It agrees in general with the drawing made by Mr. Lassell by means of the 4-foot reflector, privately distributed by him in 1860.

I expected that it would be a good representation of the same object as seen here, but in this I was quite mistaken.

The increased brilliancy of the nebula with the larger aperture quite changes its general aspect. It is an entirely hopeless task for me to attempt a drawing of this object as we see it, and therefore I must confine myself to a criticism of my paper of 1875 and to a brief description of the nebula, and wait until we can obtain a photograph of the object which will give the principal details.

Sir John Herschel's figure (*Phil. Trans.*, 1833, plate x. fig. 29) was made with the 20-foot reflector, but it shows little more than can be seen with the 6-inch finder of the large telescope. D'Arrest's two drawings ("Description of the Copenhagen Equatorial," 1861, plate ii. fig. 5; and Sid. Neb. Obs. Hav.) hardly show more of the nebula. They give beside the 14 magnitude star following the nebula (Lassell No. 1), a 19 magnitude (so-called) star, which is Lassell No. 4. Trouvelot's drawing (plate xxxiv. of "Astronomical Engravings, Harvard College Observatory") shows no stars either within or without the nebula. The criticism on this drawing given in my former paper still seems to me to be true; but, on the whole, Mr. Trouvelot's drawing comes nearer to representing what we see here than any other, not excepting my very careful pastel drawing previously referred to. I presume Mr. Trouvelot's picture to have been made with a high magnifying power.

Lord Rosse's drawing (*Phil. Trans.*, 1844, plate xix. fig. 29) shows seven stars outside the nebula, which I identify as follows:—

Lord Rosse. No.	Lassell. No.	Lord Rosse. No.	Lassell. No.
1	2	5	4
2	1	6	7
3	8	7	11
4	3		

These stars were inserted as in some sense tests of the power of the 3-foot reflector, and we may therefore assume that all stars as faint as Lassell's No. 11 were seen although they are not laid down. (Lassell's fourteen stars are numbered in the order of their brightness.)

At the same time Lord Rosse says that the speculum was probably never in first-class condition when this object was viewed. In Lord Rosse's drawing two very faint stars near No. 8 are also given, which were seen with difficulty. These are not seen here. The drawing of the nebulosity also appears to be faulty in many respects. The nebulosity within the ring is not now arranged in streaks parallel to the major axis as drawn by Lord Rosse, and as partially, and very probably erroneously, confirmed by Professor Abbe, and also by myself in 1875. With this exception, the remarks on this drawing in my paper of 1875 appear to be correct in the light of our recent observations.

Mr. Lassell's drawing of 1860 was made with the 4-foot equatorial. He shows thirteen stars without, and one (No. 14) within the nebula, and says that Nos. 12, 13, and 14 "are near the limit of vision with this telescope." "The star a little below the centre of the dark space in the nebula is faint, and from its faintness, in conjunction with my impression that it does not always appear in precisely the same place, I think there may possibly be

two nearly equal stars there, too faint to produce distinct sensations on the retina. I see no other stars whatever in the nebula, nor have I the impression that the brightest parts would break up into stars even with far more optical power."

Mr. Lassell's drawing and my own pastel drawing of 1875 represent quite faithfully the appearance of the nebula in the Washington refractor. He gives thirteen stars outside the nebula, as has been said.

In the *Astronomische Nachrichten*, No. 2139, col. 37, Herr Tempel says that with the Amici telescope of $9\frac{1}{2}$ inches aperture he sees twelve faint stars near the ring nebula, but he gives no places for these. Professor Hall in the same journal, No. 2186, col. 27, gives his measures of nine stars near the nebula. I identify these as follows :—

	Hall. Mag.	Lassell. No.		Hall. Mag.	Lassell. No.
a	13*	1	*f*	13—14	5
b	14	11	f_1	13–14	6
c	13—14	7	f_2	14–15	12
d	12—13	4	*g*	13	8
e	12	3			

Professor Hall says, "I could see no star inside the above ring of stars, nor any star within the ring of the nebula itself. I have been able to see only nine stars near this nebula."

Professor Hall's f_2 is about as faint as any of Lassell's stars outside the nebula, and I am at a loss to understand why he did not include Lassell's No. 13 in his measures, and why he did not see No. 14, which has been well seen by Professor Schultz at Upsula with the Steinheil refractor of $9\frac{1}{2}$ inches, and is seen here with the 12-inch equatorial. Lassell's Nos. 13, 2, 9, 10 clearly belong to the ring of faint stars about the nebula.

The *minimum visible* of a $9\frac{1}{2}$-inch refractor is somewhat fainter than 14 magnitude on Argelander's scale, and it is probable that Herr Tempel's twelve stars were the nine stars measured by Professor Hall, with the addition of Lassell's Nos. 2, 9, and 10.

I now come to the observations made here with the 36-inch telescope by Professor Schæberle and myself jointly. One's first idea is not so much that the aspect is unfamiliar as that it is distinctly different, that its simple structure has suddenly become complex, and finally that the task of depicting it completely is practically impossible by the ordinary methods. On one of the nights of observation Mr. Schæberle and myself were mapping new stars in and about the nebula, and we finally gave up the task not because it was ended, but because it seemed to be endless. The proper method appears to be to photograph the nebula (as we hope to do shortly), and then to add such a description and such measures as may seem to be useful.

* Professor Auwers calls *a* 11·6 magnitude.

It will be a matter of intense interest to us to compare our results with those which have been obtained by the great objectives of Pulkowa and Nice, and with those which will be obtained by the great telescopes which are now making for Mr. Common and others. In order to give a test of the light-collecting power of the 36-inch telescope, I may say that Lassell's Nos. 12, 13 (and of course 14) are easily, distinctly, and steadily seen. There are other stars outside of the ring, of which I will mention only two—Nos. 15 and 16. No. 15 is at the vertex of an isosceles triangle, of which the line 5–12 is the base, and whose altitude is twice its base. No. 15 is north of No. 12. No. 16 (first seen by Mr. Keeler) is at the vertex of an isosceles triangle whose base is the line 3–4, and whose altitude is $1\frac{1}{2}$ time its base. No. 16 is north of No. 3; it is about as faint a star as can be seen here (17 magnitude?).

Our chief attention has, however, been given to stars within the inner dark ring, and to those immersed in nebulosity. Mr. Schæberle (who has first seen most of those within the ring) has used powers of 1344 and less. I have found powers of 672 and less to be best suited for detecting faint stars immersed in the nebulosity or attached to it, as well as for seeing stars within the ring. The stars within the ring and upon the nebulosity are Lassell's No. 14 (which does not always look like a true star, but which is probably not double), and eleven other stars first seen here.

a, *b*, *c*, *d*, *e*, and *h* are within the ring; *g*, *f*, *i*, *j*, *k* are within the nebulosity. The exact position of *h* is somewhat doubtful, and it was only seen by one observer (J. M. S.). The rest have all been repeatedly and steadily seen by both of us. The following diagram gives the approximate positions:—

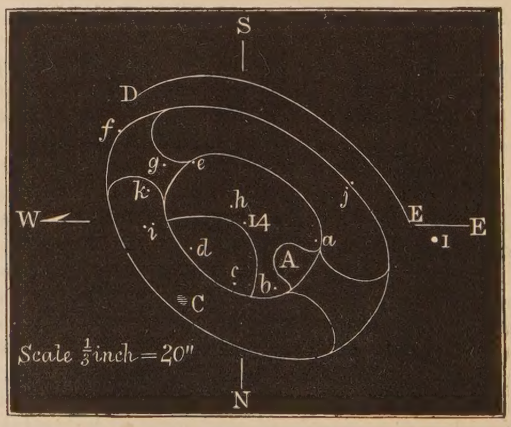


Diagram of the Ring Nebula in *Lyra*, 1888.

If the star 1 be joined with star 14, then—

Star *a* is just north of this line and inside the ring.
„ *b* is 60° north of this line, and just inside the ring.
„ *c* is 95° north of this line, and just inside the ring.
„ *d* is 150° north of this line (prolonged), and inside the ring.
„ *e* is 135° south of this line (prolonged), and just inside the ring.
„ *f* is just preceding the west end of the major axis.
„ *g* as drawn.
„ *h* (?) as drawn.
„ *i* about in the line 14 to 7.
„ *j* is about 25° south of the line 1 to 14, and just outside.
„ *k* about as drawn.

All of the above are true stars apparently; some of them are remarkably sharp and vivid in their light, notably star *f*.

There are also very many other bright points in the nebula which are presumably stars. Many of these could doubtless be fixed in position if there were any object in so doing. As I have said before, both observers thought such a task to be practically endless.

With regard to the aspect of the nebula, it may be said that the north end of the minor axis is much the best terminated. From the whole south edge faint filaments of nebulosity radiate out about as far as the line D E in the diagram. The preceding end of the major axis is the best terminated. There are several bright patches in the nebulosity, especially at the ends of the minor axis. Patch C in the diagram is about in its true position, and is probably the same patch as that seen and described in 1875. Neither the outer nor the inner boundary curves of the nebula are smooth ovals. Inside the ring it is at once seen that the space on the south and preceding side of the line 1 to 14 is darker than the rest. (See my paper of 1875, where this effect was inadequately described, because imperfectly seen.) The heart-shaped space A on the diagram is relatively bright, and has dark channels north and south of it. The space B is the brightest portion inside the ring.

It is interesting to remark that the ring nebula is situated within what Professor Hall calls a ring of faint stars; that its own shape is bounded by two ovals; that the stars within the ring are either central or on the outer oval of the dark space; and that at least two of the stars projected on the nebulosity are in critical positions on the outer oval.

It only requires a moment's examination of the nebula with this telescope to see that no description or drawing can represent the nebula to another as it is seen; but it seems that even so imperfect an account as the foregoing may suffice to show that the great 36-inch refractor is in fact and at present what Mr.

Lick's deed required that it should be, "the most powerful in the world." We have but just begun to use it regularly. In many details it is as yet incomplete, but its performance up to this time has proved to us that, if it is rightly used under suitable conditions, it will produce superb results. The chief object of this note is, as I have said, not so much to add any fact of scientific value to what is known, as to enable a judgment to be made of the power of this latest addition to the family of great telescopes.

Lick Observatory, University of California,
Mount Hamilton : 1888, *July* 15.

Observations of Nebulæ at the Lick Observatory. By Edward S. Holden, Foreign Associate of the R.A.S., and J. M. Schæberle.

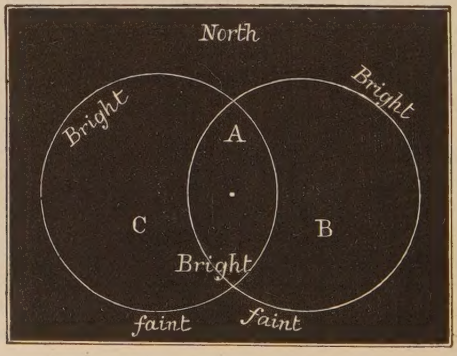
In the intervals of other work the great equatorial has been turned upon some of the more interesting nebulæ. Our observations of the annular nebula in *Lyra* have already been communicated to the Royal Astronomical Society. We beg to communicate herewith further observations upon nebulæ of the planetary class, one of which (37 H. iv., *Draconis*) has proved to be a highly complex and interesting object of a new class.

Helical-Nebula, 37 *H. iv.*, *Draconis*=*G. C.* 4373.

This nebula (of which a drawing is given) was first viewed here on July 27, 1888.

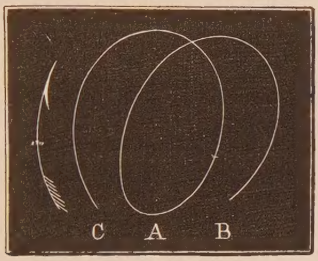
Its bright blue colour and elliptic shape make it one of the most interesting of the class of planetary nebulæ with central stars. It was examined with powers from 270 to 2000 and even higher, and bears magnifying well, losing only its characteristic and remarkable colour with the higher powers.

The nebula is apparently composed of rings overlying each other, and it is difficult to resist the conviction that these are arranged in space in the form of a true helix. The following diagram will illustrate this.



At the first glance the nebula appears to consist of two circles, C and B, which intersect so as to form the space A which surrounds the central star. At the south point of intersection the brightness is approximately twice the average brightness of the circumference; at the north point it is less bright relatively than this. A little attention, however, seems to show that these rings are so arranged that the complete ring C (360°) lies on the hither side (nearer the eye) of the complete ring B (360°); or, if we consider the helix to be generated by the motion of a luminous point in the direction of the arrow, the circumference B s last described.

A then appears to be a part of both B and C. This appearance is perfectly well seen with the central star in exact focus, and it is entirely unmistakable under these conditions with all the eyepieces. It is, however, much better seen with the eyepieces outside of the best focus for the central star. The aspect of the nebula is not changed in this way, but the brighter portions become relatively brighter, narrower, and more sharply defined.



With an eyepiece magnifying 700 diameters one of the observers (E. S. H.) focussed carefully on *Mars*, $\delta = -15°$, and the focussing scale read 2·77 inches; on *Jupiter*, $\delta = -19°$, the reading was 2·75 inches; on the central star of the nebula $\delta = +67°$, 2·76 inches. The nebula itself was well seen with the setting 2·76, but was much better seen when the focus was lengthened by $\frac{44}{100}$ of an inch (reading of scale 3·20 inches): $\frac{44}{100}$ of an inch is about $\frac{1}{1500}$ of the focal length of the objective. A suggestion of Mr. Keeler's that the longer focal adjustment on the nebula was necessary because the central star was essentially red or yellow, while the nebula was unmistakably blue, was tested on August 6, and found to be correct by means of a small pocket spectroscope by Browning. The light of the nebula with a wide slit was monochromatic and blue. The image of the nebula, under these circumstances, was crossed by the continuous spectrum of the central star in which the colours, red and yellow, were plainly visible. With a narrow slit the spectrum of the nebula was seen to consist of three lines.

The places of these lines were first determined by Dr.

Huggins, in his celebrated paper on the "Spectra of Some of the Nebulæ" (*Philosophical Transactions*, 1864, p. 438).

After viewing this object under the circumstances in which it is seen blue here, it is difficult to escape the conviction that in this instance we have the first example of a nebula whose brighter parts are arranged in a true helix. The disposition of the fainter parts has nothing to discredit this conception. In fact it is perfectly easy to conceive the true form of the whole nebula to be that of a cylinder, with the helix of the brighter portions wound upon its outer surface.

We have, therefore, ventured to designate this object as a *helical* nebula—the first of its class—because its brighter portions unquestionably *appear to the eye* in a helical and not simply in a spiral form; and also because it seems to us at least probable that the real disposition of the brighter parts in space *may be* in the form of a helix.

The accompanying figure (Plate 4, fig. 1) is the best representation which we could make. It is highly unsatisfactory at the best; and in order to present more data, extracts from our observing book of July 31, 1888, are given below.

"With power 270, focussed on a star. The central star of the nebula is also in good focus, and the helical shapes are perfectly well seen. They are also seen with the eyepiece inside of focus, and best of all with the eyepiece slightly outside.

"With power 670; the same.

"With other (higher) powers; the same. The higher the power the greater the advantage gained by viewing the nebula slightly out of focus.

"Near the *west* end of the minor axis of A is the darkest part of A; the *south* half of A is the next darkest. The *north* half of A is pretty well filled up with nebulosity.

"The whole of the interior of B is pretty dark; it is darkest towards the *north-west* edge.

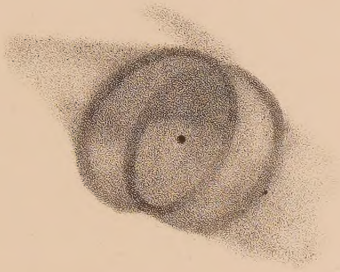
"The interior of C is darkest on the *east* and *south* sides."

Circumferences.

"The brightest part of the nebula is about 20° at the *south* extremity of A. The next brightest is about 40° in the *north-west* edge of B. The third brightest part of the circumference begins at the *north* point of A, and extends about 70° towards the *north-east* (in C). Beyond that point the circumference of C is rapidly fainter."

"Starting from the point where C and A join, at the *south*, the first 30° of the circumference is faint; the next 40° fairly bright; then comes a fainter portion; and then the circumference is bright till it joins A at the *north*, where C seems to overlie A."

"The *east* half of the circumference of A is pretty bright as far *north* as the central star, and the rest of the way it is very



37 H.IV.Draconis.

1 H.IV.Aquarii,1888 Aug 2.

E. S. Holden del.
W.H. Wesley lith

West, Newman & Co. imp.

faint. The *west* half of the circumference of A is pretty faint for the first 30° or more, commencing at the north point; and then pretty bright down to the *south* point of A."

"The circumference of B is faint and diffused from the *south* point of A to the *west* end of the major axis of the nebula; from the latter point for 70° or so it is quite bright, and fainter again before it re-joins A at the *north*."

The outlying nebulosity is about as drawn, only that it is relatively too bright in the sketch.

The only thing specially noteworthy with regard to this outlying nebulosity is the dark space lying on the *north-east* side of the whole nebula which separates two spires of nebulous matter.

A star 14 magnitude, north of the nebula in the direction of the minor axis, has a nebulous appendage on its *west* side. The central star is 11 magnitude. Another star is shown in the sketch close *south-following* the circumference of B. A node of nebulosity or a faint star is obvious in the brightest part (the *north-west* part) of the circumference of B.

"The longest diameter of A makes an angle of about 25° with the minor axis of the whole nebula, and is inclined towards the *west* at its *north* extremity."

The foregoing notes, together with the sketch, will probably serve as a sufficient description of this most remarkable of Sir William Herschel's planetary nebulæ, which seems to be the first known example of an entirely new class of objects.

Ring Nebula, 1 H. iv., Aquarii, G. C. 4628.

The accompanying drawing (Plate 4, fig. 2) gives a fair idea of the shape of this truly wonderful object. One of the best general representations of this nebula may be found in Mr. Lassell's paper, *Memoirs of the Royal Astronomical Society*, vol. xxxvi., plate x., figure 37.

The colour is a pale blue. The form of the object is perfectly well seen with the central star in focus. It is a little better seen by moving the eyepiece outside of focus until the central star almost disappears.

None of the shapes are changed by this process, but the bright central ring becomes narrower, relatively brighter and better defined, and the circular mass in which the central ring seems to lie does not lose any of its characteristics.

The central oval is not bounded by a smooth curve. It looks like an elastic link which has been warped, so that the preceding one-quarter appears beyond the median plane (further away from the eye); the central one-half appears on the hither side of the median plane (nearer the eye); and the following one-quarter again appears to be beyond the median plane.

To use a very homely comparison, the appearance of this central ring is similar to that of a footprint left in the wet sand of a sea-beach.

The central ring lies upon an oval of much fainter nebulosity, somewhat as drawn. This outer nebulosity is fairly uniform in brightness, except that there is a defalcation of light at its *south-preceding* edge, and one at its *north-following* edge, as drawn. The latter is very remarkable as seen, but it is very imperfectly depicted in the sketch. A dark band lies just *north* of the bright central ring, and one not quite so dark lies just *south* of the same ring.

The two satellites preceding and following nearly in the major axis of the nebula appear to be faintly connected with the main nebula. They are nebulous patches with a faint central nucleus, which is probably not stellar.

The central ring is brightest in the *s.p.* quadrant, in the *s.f.* quadrant, and in the *n.f.* quadrant, somewhat as drawn. Just following the *south* end of the minor axis the bright circumference becomes suddenly much fainter, as drawn. This defect of light materially aids to give the warped appearance to the surface of the interior oval, and suggests a helical arrangement of the parts.

The interior of the central oval is filled with pretty bright nebulosity at its following end, with diffused nebulosity at its preceding end, and a dark circular space surrounds the central star (by contrast?). This circular space is prolonged in a triangular shape towards the west. The preceding end of the major axis of the central ring is open, somewhat as in the ring nebula in *Lyra*. Besides the central star (or nebulous nucleus?) there is a fainter star (or node of nebulosity?) near the north end of the minor axis of the whole nebula, and two nebulous nodes in the north portion of the brighter central ring. These two nodes form a nearly equilateral triangle with the central star. It is noteworthy that Mr. Lassell, one of the most scrupulously accurate observers, places the central star south of the major axis of the inner oval. We think there is no doubt that this nucleus is now slightly north of this line.

Careful inspection fails to show a decided helical form to the nebulous mass as a whole, yet the analogy of this nebula to 37 H. iv., *Draconis*, is sufficiently striking to deserve mention.

Lick Observatory, Mount Hamilton, 1888.

Results of Observations of Sappho (80) made at the National Astronomical Observatory, Tacubaya, Mexico.

(*Communicated by the Secretaries.*)

1888.	Tacubaya Mean Time.	Comp. Star.	80 $\alpha'-\alpha$.	Log $p\Delta$.	$\delta'-\delta$.	Log $p\Delta$.	No. of Comp.
	h m s		m s		′ ″		
Mar. 31	11 34 32·9	*19	−1 10·41	9·271*n*	+3 48·91	+0·676	10:10
Apr. 2	12 17 32·7	17	+1 38·20	8·638	−2 08·81	+0·682	12:12
3	10 55 48·2	17	+ 48 20	9·386	+5 01·59	+0·664	15:15
4	11 21 38·9	14	+3 18·48	9·234	−1 59·27	+0·672	11:11
5	10 03 36·9	14	+2 27·28	9·525	+5 24·44	+0·644	10:10
9	10 23 38·3	15	−2 30·84	9·397	+4 48·96	+0·654	9:9
10	10 15 57·2	13	+ 15·33	9·408	−3 30·44	+0·660	14:14
16	10 52 01·7	9	+1 43·50	9·010	−1 07·93	+0·657	8:8
19	10 13 51·3	8	+ 36·90	9·200	+3 29·42	+0·648	10:10
24	11 08 04·1	5	− 54·98	8·526	+ 13·64	+0·644	15:15

Observer: J. Valle.

Comparison Stars.

1888.	Star.	Mag.	Mean R.A.	Red. to App. Place.	Mean Dec.	Red. to App. Place.	Authority.
			h m s	s	° ′ ″	″	
Mar. 31	*19	7·8	13 32 01·61	+1·22	−14 01 16·2	−4·24	Paris 1855, 1879
Apr. 2	17	8·9	27 26·12	+1·26	−13 40 13·5	−4·69	Weisse, Santini
3	17	8·9	27 26·12	+1·27	−13 40 13·5	−4·80	„ „
4	14	8·9	24 0·46	+1·28	−13 25 21·0	−5·06	„ „
5	14	8·7	24 0·46	+1·29	−13 25 21·0	−5·16	„ „
9	15	7	25 16·70	+1·30	−12 52 15·0	−5·33	Gould, Paris 1870
10	13	9·5	21 35	+1·29	−12 35·5	−5·50	D.M. −12° 3819
16	9	9·2	14 28	+1·32	−11 46·7	−6·04	D.M. −11° 3493
19	8	7·5	12 56·35	+1·33	−12 25 30·0	−6·29	Weisse, Santini
24	5	2·7	13 10 03·98	+1·31	−10 38 50·2	−6·37	Paris 1882

Tacubaya: June 14.

* The numbers refer to Mr. Eryant's list of comparison stars published in the January number of the *Monthly Notices* (vol. xlviii. pp. 95, 96).

Observations of Sappho 80 *with the South Equatorial and*

(Communicated by R. L. J.

1888.	Melbourne. Mean Time.			○ − ✶. Δ α.		Δ N.P.D.				App. α.			Planet. Log p × Δ.	App. N.P.D.			Log. p × Δ.
April	h	m	s	m	s	′	″		h	m	s		s	°	′	″	″
7	12	0	44·0	+0	28·30	+ 0	31·7	5	13	25	12·04	−8·606		103	8	45·2	+0·565
8	10	7	1·0	−0	22·76	− 6	56·2	5	13	24	20·98	9·406		103	1	17·4	0·594
8	10	38	25·1	−0	58·10	+ 8	49·5	5	13	24	19·76	9·294		103	1	8·9	0·582
10	10	11	20·8	+2	48·30	− 7	28·4	5	13	28	6·17	9·379		102	44	51·1	0·594
10	10	40	37·2	+1	7·90	+ 0	48·3	5	13	22	28·43	9·239		102	44	38·4	0·583
11	10	35	21·0	+0	12·19	− 7	29·8	7	13	21	32·73	9·241		102	36	20·4	0·585
12	10	58	10·3	+0	9·37	− 0	31·2	8	13	20	36·12	9·076		102	27	46·8	0·581
13	9	27	17·8	−0	43·29	− 7	54·1	10	13	19	43·46	9·448		102	20	23·9	0·609
15	9	52	34·0	−2	58·00	− 4	54·6	5	13	17	51·46	9·339		102	2	38·5	0·600
15	10	35	29·0	+1	35·57	+ 2	42·2	5	13	17	49·83	9·131		102	2	19·9	0·589
16	8	48	45·4	+0	44·23	− 5	21·6	5	13	16	58·49	9·504		101	54	16·1	0·624
16	9	27	29·3	+0	42·70	− 5	36·2	5	13	16	56·96	9·406		101	54	1·5	0·609
16	9	44	13·1	+0	41·94	− 5	41·8	5	13	16	56·20	9·352		101	53	55·9	0·603
16	10	30	11·9	+2	22·05	+ 7	1·5	3	13	16	54·65	9·134		101	53	46·2	0·591
19	9	27	59·5	+1	15·38	+ 2	33·4	15	13	14	12·62	9·357		101	28	10·2	0·609
19	10	21	46·1	−0	22·20	−18	53·5	3	13	14	10·40	9·092		101	27	51·3	0·596

Melbourne Observatory:
1888, *August* 21.

Dark-field filar Micrometer, at the Melbourne Observatory.

Ellery, F.R.S., Director.)

Red to App. Place.		Comparison Star. α 1888·0.			N.P.D. 1888·0.			Authority.
s	″	h	m	s	°	′	″	
+1·28	+5·1	13	24	42·46	103	8	8·4	Melbourne Transit-Circle
+1·28	+5·2	13	24	42·46	103	8	8·4	Anonymous do.
+1·28	+5·2	13	25	16·58	102	52	14·2	Lal. 24990 do.
+1·29	+5·3	13	25	16·58	102	52	14·2	Lal. 24990 do.
+1·29	+5·4	13	21	19·24	102	43	44·7	Lal. 24888 do.
+1·30	+5·5	13	21	19·24	102	43	44·7	Lal. 24888 do.
+1·31	+5·6	13	20	25·44	102	28	12·4	Lal. 24870 do.
+1·31	+5·6	13	20	25 44	102	28	12·4	Lal. 24870 do.
+1·32	+5·7	13	20	48·14	102	7	27·4	i Virginis do.
+1·32	+5·9	13	16	12·94	101	59	31·8	Lal. 24773 do.
+1·32	+5·9	13	16	12·94	101	59	31·8	Lal. 24773 do.
+1·32	+5 9	13	16	12·94	101	59	31·8	Lal. 24773 do.
+1·32	+5·9	13	16	12·94	101	59	31·8	Lal. 24773 do.
+1·32	+6·0	13	14	31·28	101	46	38·7	D.M. −11° 3493 do.
+1·32	+6·2	13	12	55·92	101	25	30·6	Lal. 24689 do.
+1·32	+6·1	13	14	31·28	101	46	38·7	D.M. −11° 3493 do.

Observer, P. Baracchi.

Observation of the Occultation of Saturn by the Moon, 1888, June 13. By John Tebbutt.

The occultation of *Saturn* by the Moon on the 13th instant was observed here under unfavourable conditions. The disappearances of three objects were observed at the dark limb in the following order. A star of the $7\frac{1}{2}$ magnitude, afterwards identified as $+19°$ No. 2026 of Argelander's Bonner Sternverzeichniss disappeared at the south limb at $6^h\ 41^m\ 22^s{\cdot}0$, local mean time. Had this star been a few seconds further south it would have escaped occultation. Considering that the phenomenon was almost a graze the star disappeared more suddenly than I had anticipated. The next object which disappeared was a star of the 8th magnitude a few seconds south of the planet's centre, but preceding it by about 9·4 seconds of time. The disappearance occurred at $6^h\ 50^m\ 57^s{\cdot}4$, and as this star could not be found on following evenings in the same position with reference to Argelander's star above referred to, it must doubtless be identical with the satellite *Titan*. *Saturn* was badly defined at the time of its disappearance. The indentation of the ring by the Moon's limb was first noted at $6^h\ 51^m\ 20^s{\cdot}6$. For some seconds before the final disappearance the planet appeared as a bright badly defined double spot just within the lunar limb. The last ray from the planet disappeared at $6^h\ 52^m\ 13^s{\cdot}6$. The time of the planet's actual reappearance could not be observed in consequence of a narrow band of clouds about three degrees above the horizon. When the Moon's bright limb, then boiling violently, emerged from the cloud at $7^h\ 45^m\ 48^s{\cdot}5$, the planet was seen separated from it by a few seconds of arc. As the occultation was shut out from observation with the 8-inch equatorial, the $4\frac{1}{2}$-inch telescope had to be employed.

Windsor, N. S. Wales:
1888, *June* 26.

Observations of Comet Sawerthal taken at the Adelaide Observatory. Lat. 34° 55′ 33″·8 *S.; Long.* 9ʰ 14ᵐ 21ˢ·3 *E.*

(*Communicated by Charles Todd, C.M.G., Government Astronomer.*)

Date 1888 A.M.T.	Name of Ref. Star.	Apparent Position of Reference Star. R.A.	N.P.D.	Diff. ✓−★ R.A.	N.P.D.	Correction for Diff. R.A.	Refrac. N.P.D.	Apparent Position of Comet. R.A.	N.P.D.
h m s		h m s	° ′ ″	m s	′ ″	s	″	h m s	° ′ ″
Feb. 23 15 30	...	...	...	...	...	...	...	19 41 10	140 0 35
,, 25 16 0	Argentine 27367	19 53 16·0	137 42 3	−1 4·1	−29 57	...	...	19 52 11·9	137 12 6
,, 27 15 39 36·07	,, 27562	20 2 20·04	134 13 6·03	−0 6·58	+ 7 56·4	·00	+0·2	20 2 13·46	134 21 2·6
,, 29 16 10 17·46	,, 27739	20 9 13·73	131 14 45·2	+1 17·62	+ 7 37·8	·00	+0·2	20 10 31·35	131 22 23·2
Mar. 12 16 19 55·10	,, 28854	20 57 7·49	113 4 50·1	+0 36·96	+ 0 13·3	·00	0·0	20 57 44·45	113 5 3·4
,, 18 16 40 1	,, 29400	21 21 14·45	104 4 25·3	−3 22·95	+10 15·1	−·03	+0·5	21 17 51·47	104 14 40·9
,, 26 16 57 49·96	Weisse 1056	21 46 30·89	93 42 6·7	−2 57·11	−10 38·0	+·03	−0·6	21 43 33·81	93 31 28·1
Apr. 4 17 9 49·42	,, 147	22 9 38·78	83 31 45·1	+1 46·81	−11 55·8	+·06	−0·9	22 11 25·65	83 19 48·4

From the observations of March 12, 18, and 26, the following parabolic elements have been computed by Mr. E. C. Cooke, Assistant-Astronomer.

T = Mar. 16·970 G.M.T. $\quad i = 42° 14′ 36″$

$\pi = 245° 19′ 35″$ $\quad \log q = 9·8445376$

$\Omega = 245° 28′ 6″$ $\quad$ Motion direct.

Adelaide Observatory:
1888, *May* 14.

Sextant Observations of Comet a, 1888 (*Sawerthal*), *made on board the ship "Alcester."* By Captain Leonard C. Dart.

(*Communicated by Lieut. C. W. Baillie.*)

1888, March 22. Position at noon by Dead Reckoning: Lat. 3° 24′ S., long. 88° 32′ E.

4·30 A.M. At $10^h\ 43^m$ G.M.T., comet visible; distant from *Altair* 31° 17′, distant from *Arided* 56° 4′, bearing from the planet *Venus*, W.bN., distant 12° 54′. Tail W.S.W. from nucleus about 2° in length. Sky clouded up at the time of taking bearing and did not get the comet's altitude.

Ephemerides of the Satellites of Saturn, 1888–89. By A. Marth.

In the following ephemerides the five inner satellites are assumed to move in circular orbits in the plane of the ring, the ascending node N and inclination J of which, in reference to the plane of the Earth's equator, are assumed to be

for 1889·0 N = 126°·6663. J = 6°·9887.

P denotes the position-angle of the minor axis of the ring, L + 180° the planeocentric longitude of the Earth referred to the plane of the ring, Λ + 180° that of the Sun, or Λ − L the difference between the two. The last column contains the values of $\log \nu = 0{\cdot}950 - \log \Delta$, the *Naut. Alm.* values of the distances Δ of the planet from the Earth being so altered as to take the equation of light into account.

Greenwich Noon.	P	L	Latitude of Earth above plane of Ring.	Latitude of Sun above plane of Ring.	Λ−L.	Log ν.
1888.	°	°	°	°	°	
Oct. 19	353·030	143·253	−14·114	−16·536	−5·449	9·973631
24	·045	143·582	13 980	16·570	5·602	·977211
29	·059	143·876	13·862	16·403	5·719	·980917
Nov. 3	353·071	144·133	−13·761	−16·336	−5·799	9·984729
8	·082	·350	13·678	16·269	5·840	·988621
13	·090	·526	13·614	16·202	5·840	·992567
18	·096	·661	13·570	16·135	5·799	9·996539
23	·100	·754	13·545	16·068	5·716	0·000509
28	·102	·804	13·540	16·000	5·590	·004448
Dec. 3	353·102	144·810	−13·555	−15·933	−5·420	0·008322
8	·100	·772	13·591	15·865	5·207	·012095
13	·095	·691	13·647	15·797	4·951	·015730
18	·088	·569	13·721	15·729	4·653	·019194
23	·079	·406	13·813	15·661	4·315	·022451
28	·068	144·204	13·923	15·593	3·938	·025468

Greenwich Noon.	P	L	Latitude of Earth | Sun above plane of Ring.		A−L	Log *v*.
1889.	°	°	°	°	°	
Jan. 2	353·056	143·966	−14·049	−15·525	−3·525	0·028210
7	·042	143·694	14·189	15·457	3·080	·030642
12	·027	143·393	14·341	15·388	2·605	·032736
17	353·011	143·067	14·503	15·320	2·105	·034468
22	352·994	142·720	14·672	15·251	1·584	·035817
27	·976	142·357	14·847	15·182	1·046	·036767
Feb. 1	352·958	141·982	−15·025	−15·113	−0·498	0·037303
6	·941	141·602	15·204	15·044	+0·055	·037417
11	·924	141·223	15·380	14·975	0·608	·037110
16	·907	140·849	15·552	14·905	1·155	·036389
21	·891	140·485	15·718	14·836	1·691	·035263
26	·876	140·138	15·874	14·766	2·211	·033747
Mar. 3	352·863	139·812	−16·019	−14·697	+2·710	0·031858
8	·850	139·511	16·151	14·627	3·183	·029620
13	·839	139·239	16·269	14·557	3·627	·027063
18	·830	139·000	16·372	14·487	4·038	·024217
23	·822	138·797	16·458	14·417	4·413	·021113
28	·816	138·633	16·527	14·347	4·750	·017784
Apr. 2	352·811	138·509	−16·578	−14·276	+5·046	0·014262
7	·808	·426	16·610	14·206	5·300	·010582
12	·807	·386	16 624	14·136	5·511	·006780
17	·807	·389	16·620	14·065	5·679	0·002890
22	·809	·435	16·597	13·994	5·804	9·998941
27	·812	·523	16·556	13·924	5·887	·994963
May 2	352·817	138 653	−16·497	−13·853	+5·928	·990984
7	·824	138·824	16·420	13·782	5 928	·987033
12	·833	139·034	16·327	13·711	5·888	·983137
17	·843	139·282	16·217	13·639	5·810	·979318
22	·855	139·566	16·091	13·568	5·696	·975595
27	352·868	139 885	−15·951	−13·496	+5·548	9·971988

The values of the apparent equatorial diameter of the ball and of the diameter of the outer rim of the ring depend on Bessel's determinations. The assumed proportion of the polar axis of the ball to the equatorial diameter is 0·900.

In the tables for the five satellites a and b denote the semi-axes of the apparent orbits, $l-L$ the longitudes of the satellites in their orbits reckoned from the points which are in superior conjunction with the planet's centre or in opposition to the Earth

in longitude. By adding to $l-\mathrm{L}$ the value of L from the preceding table, the longitudes l are found. These longitudes, which are the orbital longitudes from the ascending node added to the Right Ascension N of the ascending node, reckoned from the point of the true equinox, are corrected for the equation of light, and depend on the following assumed values, which refer to the time when the light arrives at the distance [0·950]:

Greenwich Noon.	Mimas. l_1	Enceladus. l_2	Tethys. l_3	Dione. l_4	Rhea. l_5
	°	°	°	°	°
1888, Oct. 29	296·415	308·828	261·452	283·796	43·120
Nov. 28	236·222	270·782	222·396	269·846	273·823
Dec. 28	176·031	232·736	183·341	255·896	144·526
1889, Jan. 27	115·841	194·690	144·286	241·946	15·229
Feb. 26	55·651	156·644	105·230	227·996	245·932
Mar. 28	355·462	118·598	66·174	214·046	116·635
Apr. 27	295·274	80·552	27·119	200·096	347·338
May 27	235·087	42·506	348·063	186·146	218·041

The values of P, a, b, and $l-\mathrm{L}$ are to be interpolated directly for the times for which the apparent positions of the satellites are required, and the rectangular coordinates x and y, reckoned parallel to the axis of the ring, or, if polar coordinates are wanted, the position-angles p, and distances s, of the satellites in reference to the planet's centre, are then found by means of the formulæ:

$$s \sin (p-\mathrm{P}) = x = a \sin (l-\mathrm{L}),$$
$$s \cos (p-\mathrm{P}) = y = b \cos (l-\mathrm{L}).$$

Greenwich Noon.	Diameter of Ball. Equat.	Phase	Polar prec. l.	Axis of Ring. Major	Minor	*Mimas.* a_1	b_1	$l_1-\mathrm{L}$	Diff.
1888.	″	″	″	″	″	″	″	°	°
Oct. 19	17·18	0·039	15·57	39·61	9·66	27·06	−6·60	292·00	1909·81
24	17·32	·041	15·70	39·94	9·65	27·29	6·59	41·81	·85
29	17·47	·043	15·83	40·28	9·65	27·52	6·59	151·66	·89
Nov. 3	17·63	·045	15·97	40·63	9·67	27·76	−6·60	261·55	·93
8	17·79	·046	16·11	41·00	9·70	28·01	6·62	11·48	1909·97
13	17 95	·047	16·26	41·37	9·74	28·27	6·65	121·45	1910·02
18	18·11	·046	16·41	41·75	9·80	28·53	6·69	231·47	·05
23	18·28	·045	16·56	42·14	9·87	28·79	6·74	341·52	·10
28	18·45	·044	16·71	42·52	9·96	29·05	6·80	91·62	·13
Dec. 3	18·61	·042	16·86	42·90	10·06	29·31	−6·87	201·75	·17

Greenwich Noon.	Diameter of Ball. Equat.	Phase prec. l.	Polar	Axis of Ring. Major	Minor		*Mimas.*		
						a_1	b_1	l_1-L	Diff.
1888.	″	″	″	″	″	″	″	°	°
Dec. 8	18·77	·039	17·01	43·28	10·17	29·57	−6·95	311·92	1910·21
13	18·93	·035	17·15	43·64	10·30	29·82	7·03	62·13	·24
18	19·08	·031	17·29	43·99	10·43	30·06	7·13	172·37	·27
23	19·23	·027	17·42	44·32	10·58	30·28	7·23	282·64	·30
28	19·36	·023	17·54	44·63	10·74	30·49	7·34	32·94	·33
1889.									
Jan. 2	19·49	0·019	17·66	44·91	10·90	30·69	−7·45	143·27	1910·34
7	19·59	·014	17·76	45·16	11·07	30·86	7·56	253·61	·36
12	19·69	·010	17·85	45·38	11·24	31·01	7·68	3·97	·36
17	19·77	·007	17·92	45·56	11·41	31·13	7·80	114·33	·37
22	19·83	·004	17·98	45·71	11·58	31·23	7·91	224·70	·38
27	19·87	·002	18·02	45·81	11·74	31·30	8·02	335·08	·36
Feb. 1	19·90	foll.	18·05	45·86	11·89	31·33	−8·12	85·44	·35
6	19·90	limb	18·05	45·87	12·03	31·34	8·22	195·79	·34
11	19·89	·001	18·04	45·84	12·16	31·32	8·31	306·13	·31
16	19·85	·002	18·02	45·77	12·27	31·27	8·38	56·44	·29
21	19·80	·004	17·97	45·65	12·37	31·19	8·45	166·73	·25
26	19·73	·007	17·91	45·49	12·44	31·08	8·50	276·98	·21
Mar. 3	19·65	0·011	17·84	45·29	12·50	30·95	−8·54	27·19	·18
8	19·55	·015	17·75	45·06	12·53	30·79	8·56	137·37	·13
13	19·43	·019	17·65	44·79	12·55	30·61	8·57	247·50	·09
18	19·30	·024	17·54	44·50	12·54	30·41	8·57	357·59	1910·04
23	19·17	·028	17·41	44·18	12·52	30·19	8·55	107·63	1909·99
28	19·02	·033	17·28	43·85	12·47	29·96	8·52	217·62	·94
Apr. 2	18·87	·037	17·14	43·49	12·41	29·72	−8·48	327·56	·89
7	18·71	·040	17·00	43·13	12·33	29·47	8·42	77·45	·84
12	18·55	·043	16·85	42·75	12·23	29·21	8·36	187·29	·79
17	18·38	·045	16·70	42·37	12·12	28·95	8·28	297·08	·74
22	18·21	·047	16·55	41·99	11·99	28·69	8·19	45·82	·70
27	18·05	·048	16·40	41·60	11·85	28·42	8·10	156·52	·66
May 2	17·88	·048	16·25	41·22	11·71	28·16	−8·00	266·18	·61
7	17·72	·047	16·10	40·85	11·55	27·91	7·89	15·79	·58
12	17·56	·046	15·95	40·49	11·38	27·66	7·78	125·37	·54
17	17·41	·045	15·81	40·13	11·21	27·42	7·66	234·91	·51
22	17·26	·043	15·67	39·79	11·03	27·18	7·53	344·42	1909·48
27	17·12	0·040	15·54	39·46	10·84	26·96	−7·41	93·90	

Greenwich Noon.		*Enceladus.* a_2	b_2	l_2-L	Diff.	*Tethys.* a_3	b_3	l_3-L	Diff.
1888.		″	″	°	°	″	″	°	°
Oct.	19	34·72	− 8·47	57·41	1313·46	42·98	− 10·48	10·59	953·26
	24	35·00	8·46	290·87	·48	43·33	10·47	243·85	·29
	29	35·30	8·46	164·35	·52	43 70	10·47	117·14	·32
Nov.	3	35·62	− 8·47	37·87	·57	44·09	− 10·49	350·46	·36
	8	35·94	8·50	271·44	·61	44·49	10·52	223·82	·40
	13	36 26	8·54	145·05	·65	44·89	10·57	97·22	·45
	18	36·60	8·59	18·70	·69	45·30	10·63	330·67	·49
	23	36·93	8·65	252·39	·73	45·72	10·71	204·16	·53
	28	37·27	8·73	126·12	·77	46·14	10·80	77·69	·57
Dec.	3	37·60	− 8·81	359·89	·81	46·55	− 10·91	311·26	·61
	8	37·93	8·91	233·70	·85	46 96	11·03	184·87	·65
	13	38·25	9·02	107·55	·88	47·35	11·17	58·52	·69
	18	38·56	9·15	341·43	·92	47·73	11·32	292·21	·73
	23	38·85	9·28	215·35	·95	48·09	11·48	165·94	·76
	28	39·12	9·41	89·30	1313·98	48·42	11·65	39·70	·79
1889.									
Jan.	2	39·37	− 9·56	323·28	1314·00	48·73	− 11·83	273·49	953·81
	7	39·59	9·70	197·28	·02	49·00	12·01	147·30	·83
	12	39·78	9·85	71·30	·03	49·24	12·20	21·13	·85
	17	39·94	10·00	305·33	·05	49·44	12·38	254·98	·87
	22	40·06	10·15	179·38	·05	49 59	12·56	128·85	·87
	27	40·15	10·29	53 43	·05	49·70	12·73	2·72	·88
Feb.	1	40·20	− 10·42	287·48	·04	49·76	− 12·90	236·60	·87
	6	40·21	10·55	161·52	·03	49·77	13·05	110 47	·87
	11	40·18	10 66	35·55	1314 01	49·74	13·19	344·34	·85
	16	40·11	10 76	269·56	1313·99	49·66	13·31	218·19	·83
	21	40·01	10·84	143·55	·96	49·53	13·42	92·02	·80
	26	39·87	10·90	17·51	·93	49·36	13·50	325·82	·78
Mar.	3	39·70	− 10·95	251·44	·90	49·14	− 13·56	199 60	·75
	8	39·49	10·99	125·34	·86	48·89	13·60	73·35	·71
	13	39·26	11·00	359·20	·81	48·60	13 62	307·06	·66
	18	39·01	10·99	233·01	·77	48·28	13·61	180·72	·63
	23	38·73	10·97	106·78	·73	47·94	13·58	54·35	·58
	28	38·43	10·93	340·51	·67	47·57	13 53	287·93	·54
Apr.	2	38·12	− 10·88	214·18	·63	47·19	− 13·46	161·47	·49
	7	37·80	10 81	87·81	·58	46 79	13·38	34·96	·45
	12	37·47	10·72	321·39	1313·54	46·38	13·27	268·41	953·40

Enceladus.

Greenwich Noon.	a_2	b_2	l_2-L	Diff.
1889.	″	′	°	°
Apr. 17	37·14	−10·62	194·93	1313·49
22	36·80	10·51	68·42	·45
27	36·46	10·39	301·87	·41
May 2	36·13	−10·26	175·28	·36
7	35·81	10·12	48·64	·32
12	35·49	9·98	281·96	·28
17	35·17	9·82	155·24	·25
22	34·87	9·67	28·49	1313·23
27	34·59	− 9·50	261·72	

Tethys.

a_3	b_3	l_3-L	Diff.
″	″	°	°
45·97	−13·15	141·81	953·36
45·55	13 01	15·17	·31
45·14	12·86	248·48	·27
44·73	−12·70	121·75	·23
44·32	12·53	354·98	·19
43·93	12·35	228·17	·15
43·54	12·16	101·32	·12
43·17	11·97	334·44	953·09
42 81	−11·77	207·53	

Dione.

Greenwich Noon.	a_4	b_4	l_4-L	Diff.
1888.	″	″	°	°
Oct. 19	55·04	−13·42	264·77	657·41
24	55·50	13·41	202·18	·44
29	55·97	13·41	139·62	·48
Nov. 3	56·47	−13·43	77·10	·52
8	56·97	13·47	14·62	·56
13	57·49	13·53	312·18	·60
18	58·02	13·61	249·78	·64
23	58·56	13·71	187·42	·69
28	59·09	13·83	125·11	·73
Dec. 3	59·62	−13·97	62·84	·77
8	60 14	14·13	0·61	·81
13	60·64	14·31	298·42	·85
18	61·13	14·50	236 27	·89
23	61·59	14·71	174·16	·92
28	62·02	14·92	112 08	·95
1889.				
Jan. 2	62·41	−15·15	50·03	657·98
7	62·76	15·38	348·01	658·01
12	63·07	15·62	286·02	·03
17	63·32	15·86	224·05	·04
22	63·52	16·09	162·09	·05
27	63·65	16·31	100·14	·05
Feb. 1	63·73	−16·52	38·19	·06
6	63·75	16·72	336·25	·05
11	63·70	16·90	274·30	·04
16	63·60	17·05	212·34	658·02

Rhea.

a_5	b_5	l_5-L	Diff.
″	″	°	°
76 86	−18·74	182·71	398·16
77·50	18·72	220·87	·19
78·17	18·73	259·06	·23
78·86	−18·76	297·29	·27
79·57	18·81	335·56	·31
80·29	18·90	13·87	·36
81·03	19·01	52·23	·39
81·77	19·15	90·62	·44
82·52	19·32	129·06	·48
83·26	−19·51	167·54	·52
83·98	19·74	206·06	·57
84·69	19·98	244·63	·60
85·37	20·25	283·23	·65
86·01	20·54	321·88	·68
86 61	20·84	0·56	·71
87·16	−21·16	39·27	398·74
87·65	21·48	78·01	·77
88·07	21·81	116·78	·79
88·42	22·14	155·57	·81
88 70	22·47	194·38	·82
88·89	22·78	233·20	·83
89·00	−23·07	272·03	·83
89·02	23·35	310·86	·83
88·96	23·60	349·69	·82
88·82	23·81	28·51	398·80

Greenwich Noon. 1889.	*Dione.* a_4	b_4	l_4-L	Diff.	*Rhea.* a_5	b_5	l_5-L	Diff.
	″	″	°	°	″	″	°	°
Feb. 21	63·43	−17·18	150·36	658·00	88·59	−24·00	67·31	398·79
26	63·21	17·29	88·36	657·98	88·28	24·14	106·10	·76
Mar. 3	62·94	−17·37	26·34	·94	87·89	−24·25	144·86	·73
8	62·62	17·42	324·28	·91	87·44	24·32	183·59	·70
13	62·25	17·44	262·19	·87	86·93	24·35	222·29	·67
18	61·84	17·43	200·06	·83	86·36	24·34	260·96	·63
23	61·40	17·40	137·89	·79	85·75	24·29	299·59	·58
28	60·93	17·33	75·68	·75	85·09	24·21	338·17	·54
Apr. 2	60·44	−17·24	13·43	·70	84·40	−24·08	16·71	·50
7	59·93	17·13	311·13	·66	83·69	23·92	55·21	·45
12	59·41	17·00	248·79	·61	82·96	23·74	93·66	·41
17	58·88	16·84	186·40	·57	82·22	23·52	132·07	·37
22	58·34	16·67	123·97	·52	81·48	23·27	170·44	·33
27	57·84	16·47	61·49	·49	80·74	23·01	208·77	·28
May 2	57·29	−16·27	258·98	·44	80·00	−22·72	247·05	·24
7	56·77	16·05	296·42	·40	79·28	22·41	285·29	·20
12	56·26	15·82	233·82	·36	78·57	22·09	323·49	·16
17	55·77	15·57	171·18	·33	77·88	21·75	1·65	·13
22	55·29	15·32	108·51	657·30	77·21	21·40	39·78	398·10
27	54·83	−15·07	45·81		76·57	−21·04	77 88	

Approximate Differences of Right Ascension and Declination between the three outer Satellites and the Centre of Saturn.

Greenwich Noon. 1888.	*Titan.* α_6-A	δ_6-D	*Hyperion.* α_7-A	δ_7-D	*Iapetus.* α_8-A	δ_8-D
	s	″	s	″	s	
Oct. 19	− 9·63	−43·7	...	...	+36·53	+1·5
20	6·02	48·3	...	...	36·60	2·4
21	− 1·55	−46 2	...	...	+36·49	+3·4
22	+ 3 15	37·5	...	...	36·20	4·4
23	+ 7·40	−23·2	...	...	+35·70	+5·5
24	10·54	− 5·5	...	...	34·98	6·5
25	+12·04	+13·1	...	...	+34·05	+7·4
26	11·60	29·6	...	...	32·91	8·3
27	+ 9·23	+41·2	...	...	+31·57	+9·1
28	5·35	45·9	...	...	30·03	9·9
29	+ 0·54	+43·0	+12·58	+36·3	+28·30	+10·7
30	− 4·37	33·1	9·84	46·4	26·39	11·3

Greenwich Noon. 1888.		*Titan.*		*Hyperion.*		*Iapetus.*	
		α_6-A	δ_6-D	α_7-A	δ_7-D	α_8-A	δ_8-D
		s	″	s	″	s	″
Oct.	31	− 8·61	+18·0	+ 5·88	+50·6	+24·32	+11·9
Nov.	1	11·55	0·0	+ 1·15	48·6	22·08	12·5
	2	−12·79	−18·0	− 3·73	+40·9	+19·69	+12·9
	3	12·18	33·4	8·23	28·6	17·17	13·3
	4	− 9·85	−44·1	−11·93	+13·4	+14·53	+13·6
	5	6·13	48·7	14·60	− 2·9	11·78	13·9
	6	− 1·53	−46·3	−16·10	−19·1	+ 8·95	+14·1
	7	+ 3·30	37·3	16·43	33·9	6·05	14·2
	8	+ 7·67	−22·8	−15·64	−46·5	+ 3·09	+14·2
	9	10·88	− 4·8	13·85	56·1	+ 0·10	14·2
	10	+12·38	+13·9	−11·18	−62·2	− 2·89	+14·1
	11	11·89	30·5	7·81	64·4	5·88	13·9
	12	+ 9·43	+42·0	− 3·94	−62·7	− 8·85	+13·6
	13	5·33	46·5	+ 0·20	56·8	11·76	13·3
	14	+ 0·43	+43·3	+ 4·33	−47·1	−14·61	+12·9
	15	− 4·62	33·1	8·16	33·9	17·37	12·4
	16	− 8·96	+17·5	+11·34	−18·0	−20·02	+11·9
	17	11·94	− 0·7	13·52	− 0·4	22·55	11·3
	18	−13·16	−19·0	+14·35	+17·3	−24·94	+10·6
	19	12·49	34·5	13·60	33·1	27·16	9·9
	20	−10·04	−45·2	+11·25	+44·9	−29·21	+ 9·1
	21	6·17	49·6	7·46	51·2	31·07	8·2
	22	− 1·41	−47·0	+ 2·73	+51·1	−32·73	+ 7·3
	23	+ 3·57	37·5	− 2·35	44·8	34·18	6·3
	24	+ 8·03	−22·5	− 7·20	+33·5	−35·40	+ 5·3
	25	11·29	− 4·1	11·34	18·7	36·39	4·3
	26	+12·77	+15·1	−14·46	+ 2·1	−37·14	+ 3·2
	27	12·17	31·9	16·41	−14·7	37·65	2·1
	28	+ 9·56	+43·4	−17·13	−30·5	−37·91	+ 1·0
	29	5·33	47·7	16·67	44·2	37·92	− 0·1
	30	+ 0·20	+44·1	−15·11	−55·1	−37·68	− 1·3
Dec.	1	− 4·98	33·3	12·60	62·6	37·20	2·4
	2	− 9·40	+17·1	− 9·30	−66·3	−36·47	− 3·6
	3	12·40	− 1·7	5·40	65·8	35·50	4·8
	4	−13·56	−20·4	− 1·14	−61·0	−34·31	− 5·9
	5	12·77	36·2	+ 3·21	52·2	32·89	7·0
	6	−10·16	−47·0	+ 7·34	−39·5	31·25	− 8·1

Greenwich Noon. 1888.	*Titan.* α_6-A	*Titan.* δ_6-D	*Hyperion.* α_7-A	*Hyperion.* δ_7-D	*Iapetus.* α_8-A	*Iapetus.* δ_8-D
	s	"	s	"	s	"
Dec. 7	− 6·10	−51·2	+10·90	−23·6	−29·41	− 9·2
8	− 1·17	−48·1	+13·51	− 5·7	−27·38	−10·2
9	+ 3·95	38·1	14·80	+12·9	25·18	11·2
10	+ 8·50	−22·3	+14·50	+30·2	−22·81	−12·1
11	11·76	− 3·1	12·48	43·9	20·29	12·9
12	+13·16	+16·6	+ 8·91	+52·3	−17·63	−13·7
13	12·41	33·8	+ 4·20	54·1	14·85	14·4
14	+ 9·60	+45·4	− 1·05	+49·3	−11·98	−15·1
15	+ 5·17	49·4	6·20	38·8	9·02	15·6
16	− 0·14	+45·3	−10·73	+24·2	− 6·00	−16·1
17	5·45	33·7	14·28	+ 7·2	− 2·93	16·5
18	− 9·92	+16·7	−16·63	−10·5	+ 0·16	−16·7
19	12·88	− 2·9	17·71	27·4	3·27	16·9
20	−13·94	−22·3	−17·55	−42·6	+ 6·37	−16·9
21	12·98	38·5	16·21	55·0	9·45	16·9
22	−10·17	−49·3	−13·84	−64·0	+12·48	−16·7
23	5 91	53·2	10·59	69·0	15·44	16·4
24	− 0·80	−49·6	− 6·67	−69·8	+18·32	−16·0
25	+ 4·45	38·8	− 2·31	66·1	21·11	15·5
26	+ 9·04	−22·1	+ 2·22	−57·9	+23·78	−14·8
27	12·25	− 2·0	6·59	45·6	26·32	14·1
28	+13·51	+18·6	+10·46	−29·7	+28·71	−13·2
29	12·57	36·2	13·43	−11·1	30·94	12 2
30	+ 9·52	+47·8	+15·13	+ 8·5	+32·99	−11·1
31	+ 4·87	51·5	15·21	27·4	34·85	9·9
32	− 0·61	+46·7	+13·53	+43·2	+36·51	− 8·6

Approximate Greenwich times of conjunctions of the satellites with the centre of the planet or of their passages in the direction of the minor axis of the ring.

"n" inferior conjunction, or satellite north, moving from the following to the preceding side.

"s" superior conjunction, or satellite south, moving from the preceding to the following side.

In the case of *Titan* and *Iapetus* the approximate distances from the major axis of the ring are added, at which they pass in the direction of the minor axis. In the case of *Iapetus* and of the fixed star of Dec. 12, the conjunctions with the ends of the ring ("f" following, "p" preceding end) are also given.

1888.	h			
Oct. 21	9·7	Tit. s.	44″	
29	4·2	Tit. n.	42″	
	7·4	Di. n.		
	7·9	Te. n.		
	17·9	En. s.		
30	6·4	Rh. s.		
	6·6	Te. s.		
	10·3	En. n.		
	16·2	Di. s.		
31	5·2	Te. n.		
	19·2	En. n.		
Nov. 1	1·1	Di. n.		
	3·9	Te. s.		
	11·6	En. s.		
	12·6	Rh. n.		
2	2·5	Te. n.		
	9·9	Di. s.		
	18·9	Mi. n.		
	20·5	En. s.		
3	1·2	Te. s.		
	13·0	En. n.		
	17·5	Mi. n.		
	18·8	Di. n.		
	18·9	Rh. s.		
	23·9	Te. n.		
4	16·1	Mi. n.		
	21·9	En. n.		
	22·5	Te. s.		
5	3·6	Di. s.		
	14·3	En. s.		
	14·7	Mi. n.		
	21·2	Te. n.		
6	1·1	Rh. n.		
	9·4	Tit. s.	44″	
	12·5	Di. n.		
	13·3	Mi. n.		
	19·8	Te. s.		
7	12·0	Mi. n.		
	15·6	En. n.		
	18·5	Te. n.		
	21·3	Di. s.		
8	7·4	Rh. s.		
	8·1	En. s.		
	10·6	Mi. n.		
	14·3	Iap. fn.	12″	
	17·1	Te. s.		
	21·9	Mi. s.		
9	0·5	En. n.		
	1·8	Iap. n.	14″	
	6·2	Di. n.		
	8·3	Di. ☌ Iap.		
	13·3	Iap. pn.	17″	
	15·8	Te. n.		
	17·0	En. s.		
	20·5	Mi. s.		
10	9·4	En. n.		
	13·6	Rh. n.		
	14·4	Te. s.		
	15·0	Di. s.		
Nov. 10	19·1	Mi. s.		
11	1·9	En. s.		
	13·1	Te. n.		
	17·7	Mi. s.		
	18·3	En. n.		
	23·9	Di. n.		
12	10·7	En. s.		
	11·8	Te. s.		
	16·4	Mi. s.		
	19·8	Rh. s.		
13	8·7	Di. s.		
	10·4	Te. n.		
	15·0	Mi. s.		
	19·6	En. s.		
14	3·6	Tit. n.	42″	
	9·1	Te. s.		
	12·1	En. n.		
	13·6	Mi. s.		
	17·6	Di. n.		
15	2·0	Rh. n.		
	4·5	En. s.		
	7·7	Te. n.		
	12·2	Mi. s.		
	21·0	En. n.		
16	2·4	Di. s.		
	6·4	Te. s.		
	10·8	Mi. s.		
	13·4	En. s.		
	22·1	Mi. n.		
17	5·0	Te. n.		
	8·3	Rh. s.		
	11·3	Di. n.		
	20·8	Mi. n.		
	22·3	En. s.		
18	3·7	Te. s.		
	14·7	En. n.		
	19·4	Mi. n.		
	20·1	Di. s.		
19	2·3	Te. n.		
	14·5	Rh. n.		
	18·0	Mi. n.		
	23·6	En. n.		
20	1·0	Te. s.		
	4·9	Di. n.		
	16·1	En. s.		
	16·6	Mi. n.		
	23·6	Te. n.		
21	8·5	En. n.		
	13·8	Di. s.		
	15·2	Mi. n.		
	20·7	Rh. s.		
	22·3	Te. s.		
22	0·9	En. s.		
	8·5	Tit. s.	45″	
	13·8	Mi. n.		
	17·4	En. n.		
	21·0	Te. n.		
	22·6	Di. n.		
23	9·8	En. s.		
Nov. 23	12·5	Mi. n.		
	19·6	Te. s.		
24	2·9	Rh. n.		
	7·5	Di. s.		
	18·3	Te. n.		
	18·7	En. s.		
25	16·3	Di. n.		
	16·9	Te. s.		
26	9·1	Rh. s.		
	15·6	Te. n.		
	20·0	En. n.		
27	1·2	Di. s.		
	12·5	En. s.		
	14·2	Te. s.		
	18·2	Mi. s.		
28	10·0	Di. n.		
	12·9	Te. n.		
	15·3	Rh. n.		
	16·9	Mi. s.		
	21·4	En. s.		
29	11·5	Te. s.		
	13·8	En. n.		
	15·5	Mi. s.		
	18·8	Di. s.		
30	2·6	Tit. n.	43″	
	10·2	Te. n.		
	14·1	Mi. s.		
	21·5	Rh. s.		
	22·7	En. n.		
Dec. 1	3·7	Di. n.		
	8·8	Te. s.		
	12·7	Mi. s.		
	15·1	En. s.		
2	7·5	Te. n.		
	7·6	En. n.		
	11·3	Mi. s.		
	12·5	Di. s.		
	22·6	Mi. n.		
3	0·0	En. s.		
	3·7	Rh. n.		
	6·1	Te. s.		
	16·4	En. n.		
	21·2	Mi. n.		
	21·4	Di. n.		
4	4·8	Te. n.		
	8·9	En. s.		
	19·9	Mi. n.		
5	3·4	Te. s.		
	6·2	Di. s.		
	9·9	Rh. s.		
	17·8	En. s.		
	18·5	Mi. n.		
6	2·1	Te. n.		
	10·2	En. n.		
	15·0	Di. n.		
	17·1	Mi. n.		
7	0·7	Te. s.		
	15·7	Mi. n.		
	16·1	Rh. n.		

1888.	h			h			h	
Dec. 7	19·1	En. n.	Dec. 16	0·4	En. n.	Dec. 24	5·6	Tit. s. 47″
	23·4	Te. n.		1·1	Tit. n. 45″		5·6	En. n.
	23·9	Di. s.		4·9	Di. s.		9·9	Di. n.
8	7·2	Tit. s. 46″		11·2	Te. s.		14·8	Mi. n.
	11·5	En. s.		14·6	Mi. s.		22·1	En. s.
	14·3	Mi. n.		16·8	En. s.		23·1	Te. n.
	22·0	Te. s.		16·9	Rh. n.	25	13·4	Mi. n.
9	8·7	Di. n.	17	9·3	En. n.		14·5	En. n.
	12·9	Mi. n.		9·9	Te. n.		17·6	Rh. n.
	20·4	En. s.		12·0	Iap. ps. 14″		18·7	Di. n.
	20·7	Te. n.		13·2	Mi. s.		21·7	Te. s.
	22·3	Rh. s.		13·7	Di. n.	26	7·0	En. s.
10	11·6	Mi. n.	18	0·0	Iap. s. 17″		12·0	Mi. n.
	12·9	En. n.		1·7	En. s.		20·4	Te. n.
	17·6	Di. s.		8·5	Te. s.		23·3	Mi. s.
	19·3	Te. s.		11·7	Iap. fs. 20″		23·4	En. n.
	22·9	Mi. s.		11·8	Mi. s.	27	3·5	Di. s.
11	18·0	Te. n.		18·1	En. n.		10·6	Mi. n.
	21·5	Mi. s.		22·6	Di. s.		15·8	En. s.
	21·7	En. n.		23·1	Mi. n.		19·0	Te. s.
12	2·3	✱ 9^mpn59″†		23·1	Rh. s.		21·9	Mi. s.
	2·4	Di. n.	19	7·2	Te. n.		23·8	Rh. s.
	4·5	Rh. n.		10·3	Mi. s.	28	8·3	En. n.
	10·1	✱ 9^mn.44″†		10·6	En. s.		12·4	Di. n.
	14·2	En. s.		21·7	Mi. n.		17·6	Te. n.
	16·6	Te. s.	20	3·0	En. n.		20·5	Mi. s.
	17·7	✱ 9^mfn30″†		5·8	Te. s.	29	16·3	Te. s.
	20·1	Mi. s.		7·4	Di. n.		17·2	En. n.
13	11·2	Di. s.		19·5	En. s.		19·2	Mi. s.
	15·3	Te. n.		20·3	Mi. n.		21·2	Di. s.
	18·7	Mi. s.	21	4·5	Te. n.	30	6·0	Rh. n.
	23·1	En. s.		5·3	Rh. n.		9·6	En. s.
14	10·7	Rh. s.		16·2	Di. s.		14·9	Te. n.
	13·9	Te. s.	22	3·1	Te. s.		17·8	Mi. s.
	15·5	En. n.	23	1·1	Di. n.	31	6·0	Di. n.
	17·3	Mi. s.		1·8	Te. n.		13·6	Te. s.
	20·1	Di. n.		11·5	Rh. s.		16·4	Mi. s.
15	7·9	En. s.		13·2	En. s.		18·5	En. s.
	12·6	Te. n.		16·2	Mi. n.		23·1	Tit. n. 47″
	15·9	Mi. s.	24	0·4	Te. s.			

By means of this list of conjunctions (the continuation of which, together with the continuation of the predicted places of the three outer satellites, will be published in the next number of the *Monthly Notices*) approximate values of the coordinates x and y of the five inner satellites may be easily found for any other time t with the help of the following little table, the argument of which is the interval τ between the time t and the time of the next preceding or following conjunction, the coordinates x and y being expressed in semi-diameters of the planet's equator. The satellites are on the same side, north or south, of the major axis

† The star is W. B. $9^h{\cdot}638$, and its assumed apparent place
$\alpha\ 9^h\ 31^m\ 48^s{\cdot}11$, $\delta + 15°\ 43'\ 2''{\cdot}6$.

of the ring as at the time of the next conjunction, and, as they move in the direction of *de*creasing position-angles, they are in the interval between a north and a south conjunction on the preceding side, and between a south and a north conjunction on the following side of the direction of the minor axis of the ring. They are at their greatest elongations, Mi. 5·7, En. 8·2, Te. 11·3, Di. 16·4, Rh. 27·1 hours before or after the times of conjunction.

τ	*Mimas.*		*Enceladus.*		*Tethys.*		*Dione.*		*Rhea.*	
h	x_1	y_1	x_2	y_2	x_3	y_3	x_4	y_4	x_5	y_5
0	0·0	0·8	0·0	1·0	0·0	1·2	0·0	1·6	0·0	2·2
1	0·9	0·8	0·8	1·0	0·7	1·2	0·6	1·6	0·5	2·2
2	1·7	0·7	1·5	0·9	1·4	1·2	1·2	1·6	1·0	2·2
3	2·3	0·5	2·2	0·8	2·0	1·1	1·8	1·5	1·5	2·2
4	2·8	0·3	2·8	0·7	2·6	1·1	2·4	1·5	2·0	2·2
5	3·1	0·1	3·3	0·6	3·2	1·0	2·9	1·4	2·5	2·1
6	3·1	0·1	3·7	0·4	3·7	0·8	3·5	1·3	3·0	2·1
7	2·9	0·3	3·9	0·2	4·1	0·7	4·0	1·3	3·5	2·1
8	2·5	0·5	4·0	0·0	4·5	0·6	4·4	1·2	4·0	2·0
9	1·8	0·6	4·0	0·1	4·7	0·4	4·8	1·0	4·5	1·9
10	1·1	0·7	3·8	0·3	4·9	0·2	5·2	0·9	4·9	1·9
11					5·0	0·1	5·6	0·8	5·3	1·8
12							5·8	0·7	5·7	1·7
14							6·2	0·5	6·5	1·6
16							6·4	0·1	7·1	1·4
20									8·2	0·9
27·1									8·9	0·0

Observers who are desirous to follow the motions of the satellites will find it of service to lay down the data of the table graphically on a sufficiently large scale, so that, by marking the corresponding times for the night of observing, they may get information about the places of the satellites at a glance.

Careful observations of the position-angles of the satellites at the times of their passing in the direction of the minor axis of the ring afford the best means for determining their orbital longitudes, and will be especially valuable while the apparent orbits are closing in, before they are intercepted by the body of the planet.

The present and the next apparition of *Saturn* are the most favourable for observing the differences of right ascension and declination between *Iapetus* and the centre of *Saturn*, and procuring thereby the best direct data for fixing the elements of

the satellite's orbit. The opportunities for observing the conjunctions of the satellite with the centre of the planet (when it may be preferable to observe position-angles and distances) should not be missed, especially those of the closer conjunctions, Nov. 8–9, and Dec. 17–18.

Ephemeris of the Satellite of Neptune, 1888–89. By A. Marth.

Greenwich Noon.		P′	*a*	*b*	*u*−U	Diff.	U	B
1888.		°	″	″	°	°	°	°
Oct.	19	324·79	16·87	8·52	264·32	612·35	129·20	−30·30
	29	324·58	16·92	8·52	156·67	·31	129·45	30·21
Nov.	8	324·36	16·96	8·51	48·98	·28	129·73	30·11
	18	324·12	16·97	8·48	301·26	·27	130·02	30·00
	28	323·88	16·97	8·45	193·53	·27	130·32	29·88
Dec.	8	323·64	16·95	8·41	85·80	·28	130·61	29·76
	18	323·42	16·91	8·37	338·08	·29	130·88	29·65
	28	323·23	16·86	8·31	230·37	·33	131·11	29·55
1889.								
Jan.	7	323·07	16·79	8·26	122·70	612·37	131·31	−29·47
	17	322·95	16·71	8·20	15·07	·42	131·46	29·40
	27	322·87	16·62	8·14	267·49	·48	131·55	29·35
Feb.	6	322·84	16·53	8·09	159·97	·53	131·59	29·32
	16	322·86	16·43	8·05	52·50	·59	131·56	29·32
	26	322·92	16·34	8·01	305·09	·65	131·48	29·34
Mar.	8	323·03	16·25	7·97	197·74	·71	131·34	29·39
	18	323·19	16·16	7·95	90·45	612·76	131·14	29·36
	28	323·39	16·09	7·93	243·21		130·89	29·55

P′ position-angle of the minor axis of the satellite's apparent orbit, in the direction of superior conjunction.

a, *b*, major and minor semi-axes of the apparent orbit.

u−U, longitude of the satellite in its orbit, reckoned from the point which is in superior conjunction with the planet or in opposition to the earth.

U + 180°, planetocentric longitude of the earth, reckoned in the satellite's orbit from the ascending node on the celestial equator.

B, planetocentric latitude of the earth above the plane of the orbit.

The values of *u*−U, P′, *a*, *b* are to be interpolated directly for the times for which the apparent positions of the satellite are required, and the position-angles *p* and distances *s* of the satellite are then found by means of the formulæ

$$s \sin (P' - p) = a \sin (u - U)$$
$$s \cos (P' - p) = b \cos (u - U).$$

The satellite moves in the direction of decreasing position-angles, and will be at its greatest elongations (*nf* in pos. P′ + 90°, *sp* in pos. P′ − 90° at distance *a*), and at its conjunctions (*sup*erior in pos. P′, *inf*erior in pos. P′ + 180° at distance *b*) at the following Greenwich times:

1888.		h	
Oct.	29	9·1	inf.
	30	20·4	nf.
Nov.	1	7·7	sup.
	2	18·9	sp.
	4	6·2	inf.
	5	17·5	nf.
	7	4·8	sup.
	8	16·1	sp.
	10	3·4	inf.
	11	14·6	nf.
	13	1·9	sup.
	14	13·2	sp.
	16	0·5	inf.
	17	11·7	nf.
	18	23·0	sup.
	20	10·3	sp.
	21	21·6	inf.
	23	8·9	nf.
	24	20·1	sup.
	26	7·4	sp.
	27	18·7	inf.
	29	6·0	nf.
	30	17·3	sup.
Dec.	2	4·5	sp.
	3	15·8	inf.
	5	3·1	nf.
	6	14·4	sup.
	8	1·6	sp.
	9	12·9	inf.
	11	0·2	nf.
	12	11·5	sup.
	13	22·8	sp.
	15	10·0	inf.
	16	21·3	nf.
	18	8·6	sup.

1888.		h	
Dec.	19	19·9	sp.
	21	7·1	inf.
	22	18·4	nf.
	24	5·7	sup.
	25	17·0	sp.
	27	4·3	inf.
	28	15·5	nf.
	30	2·8	sup.
	31	14·1	sp.
1889.			
Jan.	2	1·4	inf.
	3	12·6	nf.
	4	23·9	sup.
	6	11·2	sp.
	7	22·5	inf.
	9	9·7	nf.
	10	21·0	sup.
	12	8·3	sp.
	13	19·5	inf.
	15	6·8	nf.
	16	18·1	sup.
	18	5·4	sp.
	19	16·6	inf.
	21	3·9	nf.
	22	15·2	sup.
	24	2·4	sp.
	25	13·7	inf.
	27	1·0	nf.
	28	12·2	sup.
	29	23·5	sp.
	31	10·8	inf.
Feb.	1	22·0	nf
	3	9·3	sup.
	4	20·6	sp.
	6	7·8	inf.

1889.		h	
Feb.	7	19·1	nf.
	9	6·4	sup.
	10	17·6	sp.
	12	4·9	inf.
	13	16·2	nf.
	15	3·4	sup.
	16	14·7	sp.
	18	1·9	inf.
	19	13·2	nf.
	21	0·5	sup.
	22	11·7	sp.
	23	23·0	inf.
	25	10·3	nf.
	26	21·5	sup.
	28	8·8	sp.
Mar.	1	20·0	inf.
	3	7·3	nf.
	4	18·5	sup.
	6	5·8	sp.
	7	17·0	inf.
	9	4·3	nf.
	10	15·6	sup.
	12	2·8	sp.
	13	14·1	inf.
	15	1·3	nf.
	16	12·6	sup.
	17	23·8	sp.
	19	11·1	inf.
	20	22·3	nf.
	22	9·6	sup.
	23	20·8	sp.
	25	8·1	inf.
	26	19·3	nf.
	28	6·6	sup.
	29	17·8	sp.

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